OBSERVATIONS

ON

COMBUSTION & ACIDIFICATION;

WITH

A NEW THEORY OF THOSE PROCESSES,

FOUNDED ON THE CONJUNCTION

OF THE

PHLOGISTIC AND ANTIPHLOGISTIC DOCTRINES.

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We think our fathers fools, so wise we grow;
Our wiser sons, no doubt, will find us so.

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To HUMPHREY DAVY, Esq.

SECRETARY TO THE ROYAL SOCIETY, &c. &c.

SIR,

THE splendid offerings you have so largely made to Science by your late important discoveries, sufficiently point out the propriety of dedicating to you, the following pages, which are founded chiefly on the results of your own experiments.

I submit therefore to your examination, the opinions I have advanced; by which I have endeavoured to reconcile the phlogistic and antiphlogistic theories of Chemistry.

Should these opinions meet your approbation, I shall consider them as erected on a basis of considerable strength; and shall esteem your sanction of them, as an "ipse agmen."

With the highest respect
I subscribe myself,
Sir,
Your most obedient servant,

JOHN REDMAN COXE.

Philadelphia, *Feb.* 1, 1811.

PREFACE.

IT will no doubt be considered singular at the present day, to attempt to replace in any shape or modification, the doctrines of phlogiston in the science of Chemistry.

When, however, we perceive the gigantic strides which Mr. Davy has within these few years made, by which many opinions are shown to be erroneous, that the antiphlogistic doctrines considered as firmly established; such an attempt may perhaps be regarded as less visionary than it would have been at a very short anterior period; and as the subject of the present essay, is rather to reconcile the two contending theories, which the warmest advocates of either, could scarcely now maintain in their original

form; it is hoped it will be received with liberality, and reviewed with candour.

The discoveries of Mr. Davy, respecting the metallic nature of such important agents as the alkalies, and of many (most probably all) of the earths, whilst they at once diminish the number of the supposed simple bodies, at least as we were before acquainted with them; must have reasonably led to several deductions adverse to the usually received opinions of the present day.

By the powerful agencies which these discoveries have placed in our hands, we have almost immediately been conducted to other conclusions respecting another highly important class of bodies, the (formerly called) simple inflammables. These, consisting of sulphur, phosphorus, and carbon, appear now, conclusively to be proved to possess hydrogen as an essential ingredient. Hence, the really simple state of these bodies we are yet to learn, since at present we know them only as compounds; but it may, perhaps, reasonably be anticipated, that these also will be shewn to have metallic bases.

I should perhaps have acted with more prudence had I withheld this essay from the public eye; but as the chief part of it formed the substance of a lecture to the Chemical class, it was not to be expected that the opinions maintained would be long uncontradicted: and having in conversation, found I had been misunderstood by some; that the facts on which I rested my opinions were not sufficiently explained in the short compass of a lecture; and being urged by others to give them an opportunity of seeing it more in detail; I considered upon the whole, it would be best to publish it, even in an imperfect state; for such I must regard it, since I have not had leisure seriously to compare it with the facts and principles of the numerous writers on chemistry: and had I waited till I was free from other avocations, I might have reserved it to a distant period. I was however anxious that the doctrines might be elucidated, or their inadequacy shewn, through the judgment of others, which an intimate acquaintance with the facts and theories of this captivating science, will so readily enable

them to accomplish. I therefore have neglected the adage of "nonum prematur," since, if wrong, I wish not to continue to inculcate error in those whom it is my province to teach; and if right, I may reasonably anticipate assistance from others in perfecting the system of which this is the outline.

OBSERVATIONS, &c.

IN considering the subject of Heat, the different opinions advanced, at various periods, to explain that source of it which comes under the head of Combustion, require to be noticed.

In this very surprising process, we find a certain class of substances only is concerned. These, when heated to a certain degree in the open air, become greatly augmented in temperature, and transmit copious streams of caloric and light to the surrounding bodies. At length, a stop is put to these phenomena; and the body thus acted on, is found to have undergone a total change: it is now, no longer capable of the process, and is possessed of properties entirely new. To substances thus capable of combustion, the term of combustibles has been appro-

priated. The product formed by the process, is denominated according to the substance from which it is obtained; and is either water, an acid, or an oxyd. Thus hydrogen gas by combustion yields water; sulphur, sulphuric acid; and iron a metallic oxyd.

This peculiar change that has thus taken place, by which a combustible is rendered no longer so; has given rise to the various theories above adverted to, which have respectively borne their sway in the fields of Chemical investigation.

It would be useless here to recapitulate all the different opinions, which successively yielded to each other, until the antiphlogistic theory was supposed to have elucidated this mysterious operation, in a way to bid defiance to any future attack. Beautiful, however, as the edifice appeared, several defects have been pointed out that seem to render it less perfect than its promulgators considered it. The highly important discovery of the illustrious Lavoisier, that "in every case of combustion, oxygen combines with the burning body" is a fact, which, in all probability, no subsequent changes of the science will overturn.—Yet, even here, we may remark, some anomalies exist, which render it probable, that there are some excep-

tions to this celebrated basis of the antiphlogistic doctrine.

"If eight parts by weight of copper filings," says the learned Dr. Thompson, "mixed with three parts of flowers of sulphur, be put into a glass receiver, and placed upon burning coals, the mixture first melts, then a kind of explosion takes place; it becomes red hot; and when taken from the fire, continues to glow for some time like a live coal. If we now examine it, we find it converted into sulphuret of copper. This curious experiment was first made by the associated Dutch chemists, Dieman, Troostwyk, Nieuwland, Bondt, and Lawrenburgh, in 1793. They found that the combustion succeeds best, when the substances are mixed in the proportions mentioned above; that it succeeds *equally*, however pure and dry the sulphur and copper be, and *whatever air* be present in the glass vessel, whether common air, or oxygen gas, or hydrogen, or azotic gas, or even when the receiver is filled with water or mercury." "This experiment," adds the Doctor, "has excited great attention, and has been very often repeated; because it is the only instance known, of apparent combustion without the presence of oxygen."*

* Vol. I, p. 209. 4th Ed.

Without stopping to consider this very singular circumstance, I shall state, that other objections exist against different parts of the superstructure erected on the aforementioned basis, by which it will appear, that the explanation of combustion as depending on the fixation of oxygen, &c. does not so happily tally in all its parts.

By the antiphlogistic theory it is supposed, that when a combustible body is raised to a certain temperature, it begins to combine with the oxygen of the atmosphere; * and that during its combination, this oxygen evolves the caloric and light (in the form of flame,) which it is supposed to be united to in its gaseous state. Here, the former opinion, of the existence of phlogiston, under whatever name designated, is entirely discarded. It will, however, appear probable in the sequel, that the opinion of one general principle of inflammability is by no means so visionary as its opponents wish to establish; and that every combustible body owes its inflammability to such a principle pervading it.

In explaining the existence of flame, or the combination of light and heat, Lavoisier supposed them to constitute a part of oxygen in its

* Oxygen in its gaseous state consists of the peculiar ponderable base combined with caloric and light.

gaseous state; and that they separated from it, when it became fixed in the combustible body. It was asserted, that the capacities of oxygen and the combustible for heat and light, are less, after, than before combustion, and consequently, that they must appear in a liberated state; thus the caloric of atmospheric oxygen escapes when it loses its gaseous form, or becomes united to the burning body, as caloric escapes from a latent to a free state, when water in the state of vapour condenses to the fluid form.*—But how

* "By combustion, says Dr. Thompson, is meant a total change in the nature of combustible bodies, accompanied by the copious emission of heat and light. Every theory of combustion must account for these two things; *viz.* the change which the body undergoes, and the emission of heat and light which accompanies this change." Vol. 1. p. 599.

It is necessary to keep the above remark constantly in view in considering the subject before us—as well as the following observations of Lavoisier, to enable us to estimate the justice of his theory.

In speaking of the combination of caloric, and the formation of elastic aëriform fluids, Lavoisier observes, (p. 52, Phil. Edit.) of all bodies in nature, that "they are either solid, or liquid, or in the state of elastic aëriform vapour, according to the proportion which takes place between the attractive force inherent in their particles, and the repulsive power of the heat acting upon these; or, what amounts to the same thing, in proportion to the

can we reconcile this, with the attendant phenomena of the combustion of gun-powder, in which numerous elastic fluids are produced suddenly, from a state of previous solidity;—since these gases, by his own remarks, (see note) contain a far larger portion of caloric, than when in their solid state?

Gun-powder is composed of nitre, charcoal, and sulphur. The first is formed of nitrogen and oxygen united to potash, together with some water of crystallization.—After combustion, in which large quantities of heat and light are sud-

degrees of heat to which they are exposed." Again—p. 55. "we have already seen, that the same body becomes solid, or fluid, or aëriform according to the quantity of caloric by which it is penetrated." Again—p. 253. "we know in general, that all bodies in nature are imbued, surrounded, and penetrated in every way with caloric, which fills up every interval left between their particles; that, in certain cases, caloric becomes fixed in bodies, so as to constitute a part even of their solid substance; though it more frequently acts upon them with a repulsive force, from which, or from its accumulation in bodies to a greater or less degree, the transformation of solids into fluids, and of fluids to aëriform elasticity, is entirely owing."

It must be evident from these observations that Lavoisier regarded it as an absolute fact, that every gas contains a much larger portion of caloric than the elements which constitute it.

denly extricated, there are, probably, carbonic acid, sulphurous acid, sulphuretted hydrogen, and nitrogen gases, besides the vapour of the water of crystallization, or the gases which constitute it, either separate or combined with the others. Whence then can arise the caloric so suddenly required to retain them in a gaseous form? It will scarcely be said to come from the solid materials, since this would militate against his own opinion. And that it does not arise from the atmosphere, is evident, since the same is asserted to take place in vacuo.

Dr. Thompson, who has opposed this fact of the combustion of gun-powder, together with others, which I shall not here enumerate, to the reception of the Lavoisierian doctrine of the singular process under consideration, does not attempt to explain it by the beautiful theory he has advanced, at least so far as I perceive; and I cannot but think we have yet much to learn, before a satisfactory explanation of the process is given.

In the theory this gentleman advocates, several points must be rectified, according to the present state of our knowledge of the facts of chemistry.

I do not propose here to deprive those of my readers who can properly appreciate the very

interesting exposition Dr. Thompson has given of combustion, of the great satisfaction they will derive from perusing it as he has himself laid it down; since it will not, without injury bear to be epitomized, as the different parts are so luminously arranged, that one portion could not be omitted, without destroying the harmony of the whole. Neither indeed, would it be proper to enlarge these pages, by introducing the whole, although it would, itself, give them a value which probably they may be otherwise undeserving of.

I shall however remark, that, as the Doctor has admitted in another part of his work, the validity of those opinions which constitute hydrogen a part of the combustibles, sulphur, phosphorus, and carbon; so, he ought not to have still retained them in his theory of combustion as simple bodies: and he ought to have afforded us some insight into the probable destination of their constituent hydrogen. This omission does not, however, destroy the apparent justice of the conclusions drawn.

As I conform to the general opinions laid down by Dr. Thompson on the subject of combustion, and regard his theory as the most correct, as it certainly is the most beautiful which has yet appeared; I shall no longer dwell upon it, but proceed to state the arguments which I

conceive, establish the existence of a principle of inflammability, and to point out its importance in the doctrines of combustion and acidification.

And as by the antiphlogistic theory, the processes of acidification and combustion are supposed to be analogous, so if either is shewn to be probably erroneous, the other must share the same fate; which must also be the case with the opinions I shall advance, since both these processes, are, by them, still regarded as analogous; hence, whatever overturns the one, must prove equally destructive to the other.

The opinion of the existence of one simple principle of inflammability pervading all combustible bodies, (although for a long time considered to be firmly established,) appeared to have entirely passed away, with its strenuous defender, the venerable Priestley. This illustrious champion of the phlogistic doctrine, died in the full belief of such a principle, and was persuaded, time would again bring about the same opinion. Had his life been prolonged to the present period, he would have seen the dawn of that day which he so fondly anticipated; and in the late important discoveries of Mr. Davy, would have perceived the doctrine of phlogiston, regenerated like the phœnix from her ashes.

These discoveries appear to prove, that all those bodies hitherto classed amongst the simple combustibles, as sulphur, phosphorus and carbon, do actually contain hydrogen as a common constituent: analysis has long rendered the presence of the same principle certain, in all the compound combustibles, in large amount. Hydrogen was the principle which Kirwan, Priestley, and others, contended for, as the common one of inflammability; and by thus giving to phlogiston, a "local habitation and a name," they removed, at least, one objection, to the doctrines founded upon it. Now, when we find one peculiar principle, uniformly enter into the composition of one certain class of bodies, it can scarcely be deemed visionary to attribute to its presence, some common property of that class. This common property of that class, then, is combustibility; that common principle, is hydrogen. It may perhaps be here objected, that metallic bodies are combustible; but that, as simple bodies, they can contain no hydrogen. This position, though difficult of refutation, might easily be opposed by counter assertion:—and herein we should be greatly strengthened by the fact above mentioned, of its being a constituent in all the other inflammables. Reason would therefore lead us to conclude, that as metals are combus-

tible, although so various in themselves; this common property in them must equally depend on the presence of one similar principle. To this we may add, that as only a few months have compelled us to admit its existence in sulphur and the other (supposed) simple combustibles; so it is not improbable, that the rapid strides of chemical research, will shortly detect it as an inmate of the metals. In this sentiment Mr. Davy coincides, since his "experiments have led him to advance a view professedly hypothetical, but not without probability, which extends farther the relations of hydrogen. He supposes, that instead of being itself metallic, it may form metals; that it may be the *common principle of metals and inflammables, being confined in each with certain bases;* and under this point of view it will stand in opposition to oxygen."*

I might here mention a fact from Aiken's Chemical Dictionary (Vol. 2. p. 108.) respecting molybdena, evincing the probable existence of hydrogen in metals. When molybdena is mixed with caustic fixed alkali, (a metallic oxyd,) and fused, an inflammable gas is given out, the metal is acidified and combines with

* Murray, Supplem. p. 88.

the alkali.—I shall however lay but little stress upon this fact, because it may be said the hydrogen is evolved by the decomposition of moisture in the alkali.

Hydrogen we know is capable of reducing oxyds to the metallic state. This is supposed to arise from the hydrogen uniting with the oxygen of the metal to form water; the oxyd being thereby reduced. I do not however believe that the reduction of any metal is a case of mere simple affinity: in most cases it seems to depend on double affinity; and in the instance before us, I would rather imagine the oxygen and the metal divided between them the hydrogen present; by which a portion of water is formed, whilst the other portion of the hydrogen reduces the metal by becoming a constituent part.*

It must be remembered that all the bodies capable of reducing metallic oxyds, possess this principle, hydrogen; I believe few, if any facts oppose themselves to it.† In the reduc-

* This division of a third body, between two others in union, is strictly in unison with the laws of affinity laid down by the celebrated Berthollet.

† The only one I recollect, apparently in opposition, is the reduction by heat of calcined (or red oxyd of) mercury; for I cannot, with Dr. Priestley, suppose phlogiston to pass from the fuel through the glass, as heat and light

tion by charcoal (the most frequent method,) it is said, the charcoal unites to the oxygen of the oxyd, to form carbonic acid gas, and the metal thereby becomes reduced.—I may certainly ask what becomes of the constituent hydrogen, since it is not found in the gaseous product.—No doubt I shall be answered, it forms water with a

do: and as I cannot explain it, except on the commonly received opinion, I think it better to leave it for the present.

What influence the specific qualities of mercury may have in the determination of these results, may be hereafter a subject of consideration.—Dr. Thompson has told us that he has uniformly "failed in his attempts to cause it to undergo combustion."

With respect to the reduction of metals by hydrogen gas, I may mention that Dr. Priestley asserts, an explosion often took place in his experiments, owing to the mixture of oxygen extricated from the oxyd, with the residual hydrogen; this is denied by others, and may therefore be regarded as *sub judice*. It is however requisite that the point be ascertained experimentally, whether the water produced by the disengaged oxygen, is in the exact proportion that should form, from the disappearance of a certain quantum of hydrogen; since, it by no means follows, that a part of the hydrogen may not unite to a portion of oxygen to form water, whilst another part combines with the metal reduced; and I rather believe this to be the case, since it conforms to the principle of affinity laid down by Berthollet, of the division of a body between two others, proportionate to their affinities, and respective masses.

part of the oxygen, and is retained in solution by the gas itself. It is certainly a very convenient mode of solving a difficulty, to have always at hand a product of water, (either in a visible, or in an invisible state) which we are well assured, results from a *combination* of these two principles: but I apprehend the hydrogen is here pursuing another course dependant on the laws of compound affinity, and whilst the oxygen of the oxyd unites to the carbon of the charcoal,* the metal is reduced by the combination of the hydrogen.

I shall not pursue this point at present. I doubt not however, that the reduction of one metal in solution, by another, or by any combustible, is dependant on changes analogous to the above: but time and experiments at present are wanting to enable me fully to enter upon it. I will only remark that the reduction of metals by galvanism, appears to favour the existence of hydrogen in those bodies; since, where hydrogen is given out, they are not reduced; and when they are reduced, the hydrogen does not make its appearance.—Where, I would ask, does it go?†

* It will be seen hereafter, that I suppose a portion of the hydrogen to be still retained by the carbon, to render this base capable of acidification.

† No doubt as in other cases to form water with the

We are perhaps warranted in the belief of one common principle of inflammability, by several analogies which may be mentioned; such as a common principle of repulsion in caloric; of vision, in light; and of the communication of sound, in air.—Not to mention the generally received opinion of one common principle of acidity, oxygen;—and the former ill founded supposition of a principle of alkalescence, in nitrogen.

Indeed, we must admit that each simple element, as light, caloric, oxygen, and hydrogen, so largely diffused throughout nature, proves a peculiar and constant principle of some uniform effect, in the grand operations of the universe.

We might, in fine, here maintain, that by the Lavoisierian doctrine, the principle of inflammability has merely changed its name; since, as much is ascribed by it to *oxygen*, as ever was attached by our predecessors to phlogiston.

oxygen of the metal! Water indeed, in both the contending theories, is like "Mungo here, Mungo there—Mungo every where!" Its principles can never be present, without producing that fluid; although numerous instances shew them to be present in certain cases without union, even where, according to our present knowledge, the laws of affinity would seem to render their conjunction inevitable! If hydrogen is a principle of charcoal, why do we find carbonic acid in the reduction of metallic oxyds—unless the hydrogen attaches itself to the metallic base; whilst the oxygen unites to the carbon?

Now oxygen, we are thoroughly persuaded is essential to combustion, a *sine qua non* of the process: yet oxygen, alone, will not burn; neither will hydrogen; nor will many other bodies, even in contact with oxygen, unless hydrogen, or some combustible be present, into which hydrogen enters as a constituent. The products of combustion, as acids, oxyds, &c. will not burn. —Why? They have either entirely lost this inflammable principle, or it is so modified by the process of combustion, as to be no longer governed by the same laws of affinity that previously controlled it.*

From what has been said, we may perceive, that chemists as well as other philosophers, have been always disposed to generalize their ideas; and although at times, circumstances may seem

* It will not answer to suppose the laws of affinity unchangeable, by any concurrent circumstances: the reverse is repeatedly seen in chemical investigation. Thus we find a metal, is, under particular circumstances, capable of abstracting an acid from its alkaline combination; as in heating together in a retort equal parts of muriate of ammonia and granulated tin, a decomposition ensues; the ammoniacal gas may be received over mercury, whilst a muriate of tin is left behind. It is perhaps improper to regard such facts as arising from any instability in the laws of affinity; since, when we are fully acquainted with cause and effect, we shall find all the laws of chemistry, like those of the Medes and Persians, absolutely unchangeable.

to oppose opinions thus formed; it is not improbable, that such apparent contradiction, exists, not in fact, but merely in our ignorance of cause and effect. This very ignorance, by lighting up the dormant faculties of the mind, in pursuit of truth, may elicit facts, ultimately leading to perfection.

To enter with more precision on the subject under notice, it may be proper to take a cursory view of one main objection to the doctrine of phlogiston.

In combustion, phlogiston was supposed to escape from a combustible body, and by this separation, the properties of that body became altered; nor could it resume its former appearance and properties, until again combined with this peculiar principle. The necessity of air in the process of combustion was either altogether overlooked, or inadequately explained, until Lavoisier proved with certainty that oxygen united to the combustible, and thereby augmented its *absolute** weight. The favorers of phlogiston,

* Absolute, I mention, because its specific weight or gravity is diminished by the addition of the substance united. So that in this view, oxygen might be called a principle of levity as well as of gravity. This assumption of phlogiston as a principle of levity, is perhaps, after

obliged to explain this increase of weight of the product of combustion, ascribed it to the absence of phlogiston; but as this explanation did not so well accord with the actual loss the body was presumed to have sustained, they cut at once the knot they could not untie, by boldly maintaining it to be a principle of levity; in other words, that it was a principle, whose presence suspended a portion of the weight of a body; hence lead, which gains (say) 10*lbs.* per cent. in weight, owes this increase to the extrication of its phlogiston in the act of oxydation, which had, by its presence, rendered it, if I may so say, latent. When Lavoisier however proved the absorption of oxygen to be the cause, the long contended question of phlogiston was supposed to be settled, since its presence was deemed no longer necessary to explain the process of combustion.

Presuming however, that hydrogen really forms a constituent principle of metallic bodies, let us now see, how we can still reconcile its loss with the weight acquired. This I apprehend can readily be done, and the two contending systems united, by merely adverting to the great differ-

all not so absurd, since caloric, whose weight has never been appreciated; by expanding bodies, at least diminishes them in specific gravity.

ence of specific gravity of oxygen and hydrogen. By reference to this circumstance alone, we shall perceive, that hydrogen may be evolved, and oxygen absorbed, leaving the body itself, in question, greatly augmented in absolute weight.

One hundred cubic inches of oxygen gas weigh about 35 grains, whilst 100 of hydrogen weigh only about 2 3-4 grains; that is, the specific gravity of the former is to the latter, nearly as 13 to 1. Now if we suppose a metal to take up by oxydation, 100 cubic inches of oxygen, whilst it expels 100 of hydrogen, its weight after the process, will be equal to the weight of the original metal + 35 grains of oxygen — 2 3-4 of hydrogen, or its weight is actually increased 32 1-4 grains. By this simple statement, it follows, that a principle of inflammability may absolutely escape, without destroying the importance and validity of Lavoisier's position, that in every case of combustion, oxygen is absorbed by the burning body*.

* If some absurdities occur in the explanations of various chemical processes by the phlogistic doctrines; it will not be difficult perhaps to point out others in the antiphlogistic theory. And here we need only advert to one which has been repeatedly mentioned by Priestley, *viz.* the decomposition of water by means of sulphuric acid and iron. In this experiment, say the antiphlogistians,

A proof too in favour of hydrogen being the inflammable principle, arises from the recollec-

the acid undergoes no decomposition; but how do they prove it? Because, say they, the acid will saturate as much alkali after the process as it would have done before. But certainly, if the acid is not decomposed, it is fair to ask them with what view it is added? To this they have a reply at hand, which I shall quote from that excellent work, the Chemical Dictionary of Messrs. Aiken. "The explanation of this process, according to the antiphlogistic system, is, that the iron first decomposes part of the water, unites with its oxygen, and becomes an oxyd of iron, whilst the hydrogen, the other constituent of the water, flies off in the form of gas; and the oxyd of iron then dissolves in the acid. So that the solution is properly a sulphated oxyd of iron. If it be asked, what it is that suddenly determines or impels the iron to decompose the water, it can only, (as far as our present knowledge reaches) be referred to that *frequent but paradoxical* explanation of an affinity *beginning* to act *before* one of the substances that are the subjects of that affinity, is fully formed; that is to say, in the present instance, it is supposed to be the *affinity between* the sulphuric acid and the *oxyd* of iron, that causes the *metallic iron* to *convert itself* into an oxyd, by the medium of the decomposed water."

It may well be termed a paradoxical explanation which thus gives to inanimate matter the power of choice and of conversion from one form to another. Affinity as a power in chemistry is truly *compulsive*, and by this term it should be expressed, and not by that of *elective*. But surely if the above explanation is just, the iron might

tion, that it alone could thus reconcile the two opinions, by this very difference in specific gravity.

As combustion is undoubtedly a case of compound affinity, we may suppose with Dr.

become oxydated without the presence of the acid, since this step of the process depends solely on the water. It is however much more reasonable to regard the whole process as depending on compound attraction, or affinity, by which decomposition and recomposition, are simultaneously progressing. Thus we may suppose the oxygen of the acid to attack the iron and oxydate it, whilst at the same time, the water is decomposed, and whilst the hydrogen escapes, its oxygen unites to the liberated sulphur, producing a fresh quantity of acid, equal to that originally present. This acid instantly dissolves the new-formed oxyd, and converts it into a sulphate of iron. This is at least a less paradoxical theory than the old one: since it points out a necessity for the presence of the acid, and explains how the same quantity of alkali may be saturated after, as before the process; and it tends likewise to remove a stumbling block to the real merits of the antiphlogistic doctrines.

I would, by a similar explanation, account for the extrication of nitrogen from muscular flesh by dilute nitric acid; which has been supposed not to be decomposed, on the very principle which has been combated in the former case; and I am disposed to think, our explanations would be more generally correct, by regarding the operations of chemistry as more usually resulting from compound than from simple affinities.

Thompson, that in this process, the oxygen of the oxygen gas combines with the combustible, and produces the alteration we see in its properties; whilst the caloric of the gas unites with the (hydrogen and perhaps the) light of the combustible, and flies off in the form of flame*.

* I should be disposed to consider the escape of light, as permanent, and that it does not combine with the caloric, since in the combustion of oxygen and hydrogen gases, in forming water, although such an immense quantity of heat is extricated, the light is by no means proportional. It may perhaps be said that this deficiency of light in the combustible enables so much more heat to escape than in the combustion of any other inflammable body, in which this principle being more nearly proportional, immediately renders latent a larger quantity of the liberated caloric than takes place in the combustion of hydrogen.

I would remark, that as all combustibles owe their combustibility to the presence, as I contend, of hydrogen, so, this hydrogen, becoming changed, or forming water with oxygen, during the combustion of gunpowder, may possibly afford some clue in the explanation of that process, by which so many solid bodies are suddenly converted to the gaseous state. Its great capacity for heat above all other combustibles, and even above that of oxygen itself, according to Crawford, is no small point in favour of its being the universal inflammable principle. By Lavoisier's own experiments he ascertained, that whilst 1*lb.* of phosphorus in combustion, melted 100*lbs.* of ice, and 1*lb.* of charcoal only 95½*lbs.*—1*lb.* of hydrogen gas melted nearly

That caloric and light do not alone constitute flame, I think is evident; since, united as they are supposed to be, in the solar rays (if these two principles actually proceed from the sun), they do not reach us in that form. The reason is obvious; they cannot produce flame, unless by combination with the inflammable principle, which they always meet with as hydrogen, in every combustible body. The most powerfully concentrated solar rays, produce no flame in incombustibles:—They fuse and volatilize the hardest incombustible, 'tis true, but no flame follows; yet caloric and light are both present in the concentrated rays, as well as, probably, in the body exposed to them; but the defect of this inflammable principle, as a constituent of the body, precludes effectually the possibility of flame.

300*lbs.* of ice. Dalton makes it equal to 320, and Crawford even to 480*lbs.*—See Lavois. p. 150, and Thompson, v. 1, p. 609, &c. whose observation is well worth transcribing, since it adds support, in my opinion, to the theory I advance: "from the table it appears," says he, "that much more heat is evolved during the combustion of hydrogen, than any other substance. The heat evolved *is not* proportional *to the quantity* of oxygen which combines with the combustible; a fact which is rather hostile to the supposition that the whole of the heat evolved in combustion is furnished by the oxygen." p. 610.

Although I have said, the hydrogen escapes, yet in bodies capable of acidification, I conceive a portion of this principle is retained, without which, I contend, acidification cannot take place. —And this leads me to that part of the subject, in which I hope to render it probable, that hydrogen is, with oxygen, equally a *sine qua non* of acidification, as I apprehend it to be of combustion.

The supposition of an acid principle is as old as Paracelsus. The opinions entertained on this point at different periods I shall not detail; it is sufficient here to mention, that by the present doctrines, oxygen is supposed to be that principle.

We shall however find some bodies possessed of acid properties, in which oxygen has not been, as yet, detected; whilst, on the other hand, we shall find numerous instances of the union of oxygen with bodies, even in larger quantities than enter into acids, without giving to them any acid property: hence then we may state, that bodies are capable of oxygenation in two modes; in the one, no acidity prevails; in the other, acids are the result.

We will here ask with Dr. Thompson, whose expanded mind appears to see the imperfections of the Lavoisierian theory, at least in part;—

1. If oxygen is the *sole* cause of acidity, should it not produce an acid in all its compositions?—But this not the case in its largest union, that of hydrogen, since water alone is the result; and the same may be said of many oxyds.

2. If oxygen is the *sole* acidifying principle, should it not exist in all bodies that possess properties, characteristic of acids?—Yet this principle has not been discovered in muriatic or prussic acids; nor till lately, have any experiments rendered its existence probable in sulphureted hydrogen gas.*

3. If oxygen is the *sole* acidifying principle, ought it not to produce acid properties proportionate to its presence?—Yet muriatic acid, which possesses powerfully acid properties, and which is only supposed by analogy to contain this principle, loses the most characteristic properties of acidity when united to it in oxymuriatic acid.

4. If oxygen is the *sole* acidifying principle, should it be supposed capable of affording to bodies, properties altogether opposite?—Yet we find this to be the case; since in union with certain metallic bodies, it produces oxyds known by the names of alkalies and earths.

* See Davy's late experiments on Sulphur.—Also, Murray's Supp. p. 102.

If then we consider it as a fundamental axiom, that oxygen is the principle of acidity, we must include among that class, many bodies having no resemblance to acids; or exclude several which possess the properties of acids in perfection.

Since then it is plain, many facts militate against this generally received opinion that oxygen is the *sole* acidifying principle, how is the process of acidification to be explained?

To this I reply, that although with a few exceptions,* oxygen appears to be a *sine-qua-non* of acidity, yet something else is required in union with it to give the full effect of acidity.

Now we know that oxygen alone has no property of acidity; nor does it excite acidity, in the case of its largest union, as we see in its combination with hydrogen, as water. Hydrogen is one of the simple combustibles; indeed, the only one. In what does it differ from phosphorus, sulphur and carbon; combustibles likewise, and capable of forming acids by uniting to oxygen? Mr. Davy has shewn, that these bodies possess hydrogen as an essential constituent. To this

* It will be seen that I consider these exceptions to be *only apparent*, and that future investigation will discover oxygen in every body possessed of acid properties.

addition it is, that I ascribe their capability of acidification by uniting to oxygen.

We may perhaps strengthen the argument by the remarks of Dr. Thompson (vol. 1. p. 99. 4th edit.), that "Hydrogen, as far as we know at present, is really a simple body; but charcoal, phosphorus, and sulphur, are certainly compounds, containing hydrogen as a a constituent. Whether this hydrogen enters into the acid compounds which these three bodies form with oxygen; or whether these acids consist merely of the other unknown constituent combined with oxygen, has not been determined. But the first of these suppositions is probable, though it would be difficult to ascertain its truth by actual experiment."

How could this sagacious observer miss the truth of its being absolutely essential to acidification? It is, in my opinion, begging the question too far, to suppose that hydrogen, (which does not palpably escape) *inevitably* and *invariably* produces water with a portion of the oxygen during the acidification of combustibles:—as it does not do it, in the compound combustibles, at least, in toto; so neither does it here, if we may be permitted to reason from analogy.

I may remark, that if the bases of sulphur,

phosphorus, and carbon, should prove metallic, as has been supposed, it will be an additional proof of hydrogen being a constituent of metallic bodies. The reason why they do not appear as metals, may arise from the presence of a small portion of oxygen which Mr. Davy has shewn to exist likewise in them.*

I shall, of consequence, be here asked, If hydrogen is a *sine-qua-non* of acidification to combustible bodies, why, itself a combustible, and combining with a larger amount of oxygen than either of them, water is produced, and not an acid? To this I reply, *the hydrogen wants a base;* by its union to which, oxygen can then, induce acidity. Hence, although 100 parts of hydrogen combine in combustion, with 597 parts of oxygen, nothing but water can result. Whilst 100 parts of sulphur united to only 138 of oxygen, produces sulphuric acid;—100 parts of phosphorus united to 154 of oxygen, form phosphoric acid; and 100 parts of carbon combine with 257 of oxygen to produce carbonic acid gas. It may possibly be hereafter shewn,

* Oxygen, hydrogen, and a peculiar base, are insufficient to produce acidity, unless the ingredients are in due proportions; since those bodies, in which all these principles combine, require the addition of more oxygen to produce the effect.

that the union of oxygen in these cases, is in the inverse ratio of the quantity of hydrogen these bodies possess; and it may arise from its larger amount in carbon, that we find this acid in the gaseous form.* A curious circumstance according to Dr. Thompson, is, that the corrosive qualities of the acids become stronger, the *smaller* the quantity of oxygen necessary to saturate the combustible in these three bodies;—which, in connection with the fact, that oxy-muriatic acid, so largely abounding in oxygen without possessing corresponding acid properties, tends to strengthen the opinion, that something more than mere oxygen is required in the acidification of combustibles.

With respect then to water, the reason is plain, why no acid should be produced, although formed by the largest union of two principles, both essential to acidification.—The hydrogen is not in union with any base. What, I shall be asked, is the proof of the necessity?—

* This principle, seems to be a great source of the gaseous state of many bodies.—Thus the sulphureted, phosphoreted, and carbureted hydrogen gases;—thus ammonia, and perhaps other bodies, owe this state entirely to the quantum of its presence; since the bases of all of them form solids or liquids with oxygen alone, which is itself a gaseous body.

Those cases above stated, are in themselves perhaps sufficient to demonstrate it. But I will reply, add to this hydrogen a base, and acidity then results from its combination with oxygen. Look at all the numerous class of vegetable and animal acids, and we find not one in which hydrogen is not a constituent,* in union with car-

* Of 37 acids enumerated by Thompson, it would appear that 25 possess hydrogen as a constituent: these are

Sulphuric, Sulphurous	- - -	Sulphureted hydrogen gas
Phosphoric		Mellitic
Phosphorous		Tartaric
Carbonic		Citric
Acetic		Kinic
Benzoic		Saclactic
Sebacic		Uric
Succinic		Malic
Moroxylic		Suberic
Camphoric		Formic
Oxalic		Prussic
Gallic		Tannin.

Four probably contain it: *viz.*

Nitric	Boracic
Nitrous	Fluoric.

Five metallic acids: *viz.*

Arsenic	Molybdic
Tungstic	Chromic
Columbic	

also, if hydrogen is a metallic constituent; whilst

bon, or nitrogen, or both. This last indeed enters into the composition of but few, and gives as might be expected, distinctive properties.—Hydrogen however exists in them all; and what is worthy of remark, it forms an undisputed ingredient in all those of this class of acids, in which as yet no oxygen has been detected. Hence then, if there are some few acids in which we cannot shew the presence of hydrogen, we see others deficient in oxygen; and I am thereby only confirmed in opinion, that both are required to acidify bodies; and that further discoveries will demonstrate their respective existence in those bodies, in which at present, we think them deficient.

To return however to the class of vegetable acids:—In these, the variation in quantity of the base, and hydrogen, produces a correspondent change of affinity for oxygen; and by these variations, different acids are produced. Hence, by different processes on the same body, or by ab-

three are doubtful, or rather unknown: *viz.*

Muriatic Oxymuriatic

Hyper-oxymuriatic.

But the frequent suppositions of hydrogen being the base of muriatic acid, at least render it probable that it enters into its composition.

straction or addition of portions of the ingredients, one vegetable acid is often converted into another; and probably, by future improvements, we may be enabled at pleasure to change each into the other.*

This however is not the case with the more powerful acids.—Here, a certain positive proportion of the ingredients seems essential, which cannot be altered without absolutely destroying the acid itself. That these acids should not be convertible into each other, is by no means extraordinary, since the peculiar character of each is discriminated by bases of specific difference; whilst in the vegetable acids convertible into each other, the same base exists throughout.

It will probably be here said, that nitric acid

* Hence it is that we perceive a variety of vegetable acids formed in processes, from substances not containing them in a natural state, but in which the altered play of affinities, unite principles in different proportions from what had previously existed. Thus we see acetic acid produced in the formation of some of the ethers. Carbon may be said to hold a kind of middle rank, since it forms in one proportion carbonic acid in a gaseous state, whilst the proper vegetable acids are more generally solid or fluid. And this diversity may probably arise from the difference of the quantities of the carbon and hydrogen. In carbonic acid gas the hydrogen may predominate largely above its amount in the more fixed vegetable acids.

consists of oxygen and nitrogen, in which no hydrogen exists. Mr. Davy's experiment however, though not conclusive, lead to the suspicion of nitrogen being a compound of the elementary matter of hydrogen. Indeed it has before been supposed to contain it, but no decisive experiment has I believe conclusively affirmed it. At most then, this acid must be considered as neutral on the question, until the point is settled as to its composition: since at present, it cannot be absolutely shewn, as adverse.

With respect to muriatic acid, I need scarcely mention, that hydrogen in some form or other has been always supposed to enter into its composition; but even should it be contended not to be the case; so neither, as yet, has oxygen been proved to be a constituent. Hence it follows, that if not favourable to the opinion here maintained, it is not more so for the Lavoisierian theory.

Should Mr. Davy's late ideas respecting oxymuriatic acid* prove correct, at least so far as

* "The substance of the late discoveries communicated by professor Davy to the Royal Society is as follows:

1. That the oxymuriatic acid is a simple body, belonging to a class, in which two bodies only at present are known, this, and oxygen.

2. that like oxygen it forms bodies, which are either

to prove it the oxygenising principle of the muriatic acid, it may perhaps be requisite somewhat to modify the opinions here advocated; especially as hydrogen is supposed the substance acidified: although I have little doubt, whatever, eventually is found to constitute it, that both hydrogen and a base will compose it in part. I shall here state a fact which I re-

acids, or analogous to acids, or oxyds, by combining with combustible bodies.

3. That hydrogen is the basis of the muriatic acid, and that oxymuriatic acid is its acidifying principle.

4. That phosphorus, sulphur, tin, arsenic, &c. by combining with oxymuriatic acid, form substances analogous to acids, which have the power of neutralizing ammonia, and probably other alkalies, and of forming combinations with other compounds of the same class.

5. That phosphorus acidified by oxymuriatic acid, forms a compound with ammonia not decomposable by a white heat, and having characters analogous to an earth.

The combinations of oxymuriatic acid with inflammable bodies offer objects of investigation of a perfectly novel kind, analogous to, and scarcely less interesting than those belonging to the combinations of oxygen.

The chemists of the phlogistic school supposed only one principle of inflammability. Lavoisier in his beautiful generalization, was acquainted with only one acidifying principle, or one principle which rendered bodies soluble; but there is actually another known, *viz.* oxymuriatic acid; and it is not impossible but others may be discovered." Nichols. Journ. Sept. 1810.

member, long before I knew any thing upon the peculiar nature of these acids, which possibly may tend to elucidate their formation. More than once in bathing in the sea, I well recollect the peculiar smell, and sensation excited on the pituitary membrane after emerging from the waves. Assuredly, by some process of the animal economy, the muriatic acid therein contained, must have separated from its combinations, and by some means been decomposed (if Mr. Davy's opinion is correct), or else united to a portion of oxygen, giving off that very singular sensation and characteristic flavour, that so peculiarly distinguishes the oxymuriatic acid; and which, although many years had elapsed, I again recognised, when I became familiar with this extraordinary gas. However accomplished, I am nevertheless well satisfied of the truth of the observation, and hope this enunciation of it may be verified by the remarks of others *

If my general position is true of the necessity of hydrogen to the formation of acids, there can then be no doubt of its existence in the fluoric acid; especially since the experiments of Mr.

* Since writing the above, a friend to whom I communicated it, assured me he had experienced the same; although it had never been the subject of consideration, until I had called his attention to it.

Davy have rendered it probable, that its base is of an inflammable nature:* and the same may be urged with perhaps more force, as it applies to the acid of borax.

Should future experiments however prove the non-existence of hydrogen in them, which I think improbable; I should be disposed to regard them as anomalies in acidification, like those of the expansion of water by cold, or the thickening of sulphur by heat, contrary to the generally established laws of caloric. In all these cases, too, it ought to be remembered, that it does not depend on *quantity* to prove the fact; since we may, perhaps, never be able to appreciate the exact amount of this principle, that may be required to qualify a base for acidification, nor even the proportion of the base itself that may be requisite. This idea will not be considered absurd, when we recollect the very different properties of iron and steel, produced by the combination in the latter of a very small proportion of plumbago; and that the new matter added to mercury, in its amalgamation with ammonium, is supposed by Mr. Davy to be only $\frac{1}{12.000}$th part; by which, however, the specific gravity of the mercury is reduced to

* Phil. Trans. 1809. Murray's Supplement.

less than 3. As this gentleman well remarks, "very minute differences in chemical composition, may produce great differences in the characters of bodies." We shall not then wonder that one base may require an infinitely larger proportion of hydrogen to render it acidifiable than another, especially since we see the same diversity in the quantity of oxygen.

There are a few of the metallic bodies which are acidifiable, by uniting with oxygen: probably means may be hereafter found to convert that whole class into acids. If metals are compounds, as I believe, of some base with hydrogen, the theory of acidification here proposed, will receive additional strength. Indeed if the theory is correct, then it will also substantiate the compound nature of metals, since, like a circle, these opinions revolve into each other. Were I disposed to advance still further into the fields of conjecture, I might here assert my belief, that such metals as are, or shall be found, incapable of acidification, lose this capability, by a total privation of hydrogen in the process of combustion or oxydation; whilst such only can be acidified, that retain a portion with their base, even in the state of oxyd. No reason that I perceive exists against this opinion; and it may yet be proved by future experiments.

It is however more probable that all metals are capable of acidification.

" It is, perhaps, no improbable conjecture," says Lavoisier, p. 224, " that all the bodies in nature may be referred to one class of simple combustible elementary substances, to oxygen, and to caloric; and that, from the various combinations of these with each other, all the variety produced by nature and art may arise. The only known difference between metals and pure combustibles, as they are called, is in degrees of qualities. They are all combustible, that is, they all combine with oxygen, though under different degrees of temperature. They are all solid, or liquid, or aëriform, fixed or volatile, at different temperatures. In different degrees of saturation with oxygen, they form oxyds, which have alkaline properties, or acids. In the state of oxyds the formerly known metals have all the properties, of what were formerly called primitive earths, which are now at least suspected of being metallic oxyds, &c. &c."

In these opinions, which I have thus advanced, opinions certainly to be received with caution, since they form an important change in the aspect of chemistry, and aware, as I am, of their being as yet immature; we shall perceive as great a coincidence between the processes of

combustion and acidification, as is maintained by the theory of Lavoisier. Hydrogen forms in the present, as prominent a feature as under the old phlogistic doctrine; and the two theories are hereby made to unite, in, as I conceive, a perfect state of harmony.—We shall probably find, that oxygen, hydrogen, and metallic bases, together with light and caloric, are the only simple substances in nature; from the union of which, all the varied combinations around us, take their rise. The sole difference between acidification and combustion, I apprehend to be this;—all combustibles, as the term implies, are capable of combustion, but all, are not equally capable of acidification. Now in both cases, oxygen is retained in the product formed; but the difference in those products, arises from the detention of a portion of hydrogen in cases of acidification, which is removed in the other. We may observe, that the analogy between these processes, is also shewn by the fact formerly mentioned of sulphuret of copper burning without the presence of oxygen; and the existence of some acids in whose constitution oxygen has not been yet detected. In both these cases, we however still find hydrogen present.

I have, in the preceding part of this essay,

mentioned Mr. Davy's discovery that a certain class of bodies, *viz.* the alkalies and the earths, are true metallic oxyds: in the state we usually see them, they are compounds of their respective bases and oxygen. Thus we perceive, that the same principle, oxygen, which is essential to acidity, is equally requisite to induce alkalescence; a property, the absolute reverse of the former state.

It may, with great propriety be here demanded, how I can reconcile this fact, with the position I have advanced of hydrogen being essential to acidification; and being considered as a part of these metals, how alkalescence, and not acidity, should result. Now here, I apprehend, the theory I have advocated, of the necessity of hydrogen to acidification, may serve to elucidate this seeming contradiction, whilst it receives at the same time, itself, additional support.

I have asserted that hydrogen is essential to acidification, and that oxygen is equally requisite. Neither, separately, is capable of producing this effect; nor even in conjunction, except some base be present, and all in due proportions. It follows, that if either principle be here defective, acidity cannot result. If then, we take the metal of potash as the example, we find it united to hydrogen; if by any means this

hydrogen be displaced by oxygen, the property of alkalescence becomes apparent. The defect of hydrogen allows of alkalization, by the union of the base and oxygen; whilst the separation of the oxygen and restoration of hydrogen restores it to the metallic state. The pure or caustic potash is then the base of the metal (or the metal deprived of hydrogen), united to oxygen. Could both these principles combine together in the base, acidity might possibly occur.

The rapacity of the base for oxygen, is strongly shewn by the facility with which it decomposes water, and becomes converted to the caustic state; at the same time, the hydrogen of the metal combines as flame with the oxygen of the atmosphere, producing a portion of water equal to that decomposed. It is evident then, provided the theory be correct, that no possible oxygenation could endue this base with acid properties.

The same reasoning will apply to sodium, and probably also to the earthy metals; but when I come to apply it to ammonia, hydrogen abruptly presents itself, and leaves me altogether in the dark how to resolve this difficult subject. It is indeed, the most formidable objection to the opinions thus advocated; nor can I extricate myself from the difficulty, in any better manner,

than by referring to the fact formerly maintained, of the different results which arise from a variation in the quantities of the principles themselves. The play of affinities by a few simple bodies, produce, without decomposition, numerous results, entirely differing from each other, which still augment the number by uniting together from this state of primary combination. Of this I shall instance the union of the very principles which constitute the substance in question, ammonia.*

* The proof I shall give of the endless play of affinities, is that which arises from the union of hydrogen, oxygen and nitrogen with each other, primarily; and in the subsequent union of the bodies thereby produced.

In this, I shall regard ammonia, as formed by the combination of nitrogen and hydrogen, without taking into view the supposed presence of oxygen, lately attached to it.

Oxygen and nitrogen form nitric acid.
Oxygen and hydrogen form water.
Nitrogen and hydrogen form ammonia.

Here then, from three simple elementary bodies, united amongst themselves, we have three different substances compounded by simple affinity, with qualities totally distinct and opposite : *viz.* an acid, an alkali, and water.

In looking into the tables of single affinity, it will be seen, that oxygen has a more powerful attraction to hydrogen than to nitrogen; that nitrogen has a stronger

I will add also, that as oxygen is found to constitute a part of ammonia, by Mr. Davy's experiments, so, if it be contended not to be the alkalizing principle, with equal force may it be denied to be that of acidity*; since in the case

attraction to oxygen than to hydrogen, and that hydrogen has a stronger attraction to oxygen than to nitrogen.

Let us now add water to the nitric acid, and we have diluted nitric acid, composed still of only the same three principles, nitrogen, oxygen and hydrogen; the oxygen being in the double proportion which produces water and nitric acid. Again, let us now unite the ammonia with the diluted acid; here, we should suppose from the affinities above mentioned, that the ammonia and acid would be broken up, and the oxygen of the acid unite to the hydrogen of the ammonia to produce water, leaving a quantity of gaseous nitrogen: but no! nitrate of ammonia is produced; and we have thus, nitrogen in its donble state of union, with hydrogen as ammonia, and with oxygen as an acid, producing in combination a neutral salt; which is thus formed of the three original elements, constituting, in a different proportion diluted nitric acid, and from which it consequently can only differ, from this difference in the proportions of the respective principles.—Yet no similarity exists between diluted nitric acid, and the neutral nitrate of ammonia, nor do the various elements quit their original state of union, in these various combinations by single, and compound affinities.

* Or even to form water with hydrogen, which is here present, and to which it possesses an affinity stronger than to nitrogen.

before us, it has the base of nitrogen to act on. I can then only perceive in the variation in proportion of the principles united, the reason for this anomaly in the result ;* and if the slightest variation in proportion occurs, we cannot but anticipate a correspondent variation in the issue; since chemistry continually evinces, that material changes result in the affinities of bodies, by every variation in their respective masses.

I might suggest, too, that in the present case, hydrogen acts an important part in giving to this alkali, its characteristic volatility.

I have thus endeavoured to unite in one point, the two great, and long contending systems,

* I might here mention an anomaly equally extraordinary, in the various combinations of nitrogen. In the large proportion which it holds in atmospheric air, the oxygen does not combine with it to form an acid ; nor even does the nitrous oxyd (in which it is already united to a portion of oxygen) produce decomposition in the atmosphere, or unite to a larger quantity of oxygen when alone exposed to it : yet, when these bodies are already combined as nitrous gas, they immediately abstract an additional dose of oxygen when exposed to it, and produce an acid : and here too we may observe that the very principles form the nitric acid, which in a different proportion constitute ammonia.

which, until lately agitated the chemical world. By this union, I have endeavoured to maintain the high importance of oxygen, in combustion and acidification; and have also ventured to characterize it as the principle of alkalescence. —At the the same time I have maintained the equal importance of an inflammable principle, (whether denominated hydrogen or phlogiston) in the two first named processes. In union, or alone, these two important agents, seem to divide the extensive and interesting field of chemical science. United, they form the immense mass of waters, which serve as reservoirs, to preserve them in a latent state, till called for by the agencies of affinity:—and perhaps this immense diffusion itself of these two bodies, might serve as an argument, in favour of the opinions I have advocated. In a state of separation, hydrogen, united to certain bases, gives the character of metallic bodies; whilst the same bases in union with oxygen alone, are marked by the distinctive characters of oxyds, modified in both cases, by the peculiar nature of the base itself; hence, arise, in some instances, those peculiar oxyds to which is attached the name of alkalies. —By the union of these two principles together, in certain bases, the variety of acids spring into existence. If we find objections to the opinion,

of the necessity of hydrogen in the process of acidification, from perceiving this principle, *apparently*, absent in some cases; the same objections are found to exist with respect to oxygen; so that both are strictly on the same footing. When we review the other processes of nature, and perceive the continual necessity for these two principles, either separate or conjointly, I cannot but believe in the opinions I have advanced, and maintain still, the doctrine of phlogiston thus modified.

In the immature exposition of a theory, formed upon the facts which have been detailed I perceive much that is open to criticism. Yet these facts press so strongly upon my mind, that whether right or wrong in the conclusions I have drawn from them; I cannot persuade myself the antiphlogistic doctrines are perfect, or that those of phlogiston are incapable of support. I have endeavoured to shew that, by their union, several points may be, apparently better explained, than by either theory alone; and as my sole desire is, to see the doctrines of chemistry, as perfect as possible; as I have candidly avowed the reasons of my dissent from those at present taught; and have not endeavoured to conceal what may appear adverse to those herein brought forward; so, I trust that candour and

liberality will mark the review which they are calculated to elicit: nor shall I for an instant doubt, if the edifice can be strengthened by the observations of others; that such observations will be given with equal cheerfulness, as any which oppose it will be received by the author.

Before I conclude, I shall beg permission to make a few remarks on the name of hydrogen, as attached to this inflammable principle, herein contended for.

If the opinions here maintained, should be found correct, then, consistently with the principles upon which our nomenclature is founded, hydrogen will be an incorrect term for this important agent; since, although it forms water, by its union with oxygen, yet it is through the instrumentality of combustion that this takes place, when only these two bodies are brought together. In all other cases, other affinities are effecting the change in an invisible manner; but the open and direct union, by which its nature was first developed, appears the most proper state on which to found its characteristic name.

As we presume the necessity of hydrogen to acidification, is rendered as obvious as that of

oxygen, so with equal propriety might hydrogen be called oxygen, which implies a generator of acids. Now, as this is not the case independently of hydrogen so, in fact, oxygen ought also to receive a new denomination, and that more especially, since it probably is the principle of alkalescence.

Again, as hydrogen forms ammonia with nitrogen, so, founded upon this relation, its present term is perhaps improper. In fine, nothing seems better adapted to characterise it than a name derived from its principle quality of inflammability; since it is from this principle, that all combustibles derive that property, and it is from it, as a result of combustion, that they are converted into oxyds, acids, &c.—Hence as the only really distinctive property of hydrogen, is that of inflammability, so, no term is more appropriate, than the long exploded one of phlogiston*.

* Dr. Mitchill has long since proposed the continuance of this term; and has given many very excellent remarks on the impropriety of that of hydrogen, which the reader may see, by referring to the first volumes of the Medical Repository. As the Dr. is far from uniting fully in all the antiphlogistic opinions, and as I trust there are many more, who do not implicitly embrace it, in all its branches; so I hope I may not stand alone in the remarks I have ventured to make.

The period since it was first called hydrogen, is not so far gone by, that a change of name would be improper; especially since I believe many enlightened German chemists still support the idea of phlogiston. Time has not rendered the name of hydrogen, equally sacred with that of phlogiston; and its combinations under this last name will be equally easy of remembrance, as under that of hydrogen.

I would only propose so far to conform to the general nomenclature, as to give it the termination *en* instead of *on*; although this perhaps is of less importance, since it does not convey the strict meaning contained in the generic termination, *gen.*

With respect to its combinations, they would be as follow:

Phlogisten——Caloric — Phlogisten gas.
Nitrogen — Ammonia.
Oxygen — Water; Oxyd of Phlogisten
Sulphur, Phosphorus, Carbon — Phlogisturet of &c. &c.
Metals — &c.

Phosphoreted hydrogen gas, sulphureted hy-

drogen gas, carbureted hydrogen gas, would, in a little time be sounded with equal ease as phosphoreted phlogisten gas, &c. &c.

At any rate, if it is of importance to have names conveying the actual quality of bodies; and as the framers of the new nomenclature (some of whom are still living) maintain the propriety of establishing the names of things, on a sure basis; it follows, that if hydrogen be really the principle of inflammability, a name conformable to it should at once be adopted, before time has thoroughly consecrated its present denomination.

FINIS.